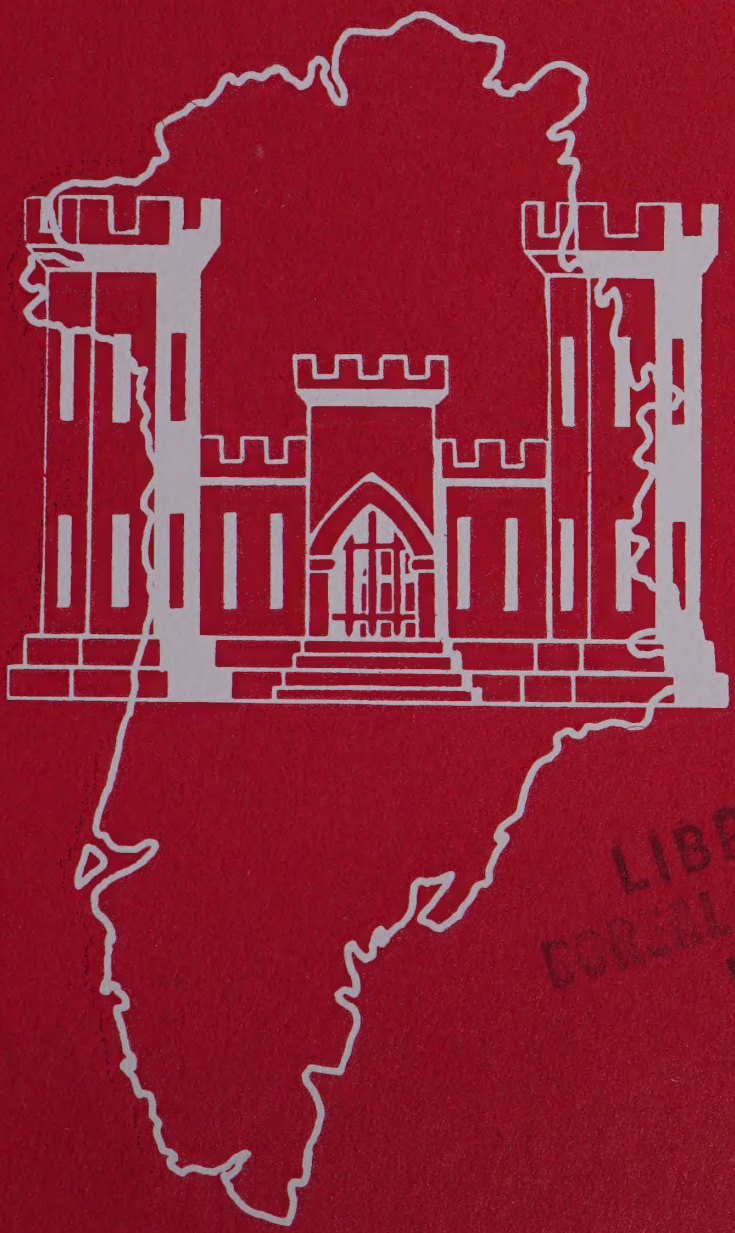
GREENLAND RESEARCH AND DEVELOPMENT PROGRAM

U.S. ARMY POLAR R & D CENTER

1958 AFTER OPERATIONS REPORT



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PREFACE

The authority for the 1958 Corps of Engineers Research and Development Program in Greenland is contained in a letter from the Office of the Chief of Engineers, ENGNB, subject: "Authority for Chief of Engineers R&D Program in Greenland—Summer 1958," dated 19 February 1958.

The U. S. Army Polar R&D Center was the coordinating, supervising, and supporting organization for the research and development projects in Greenland. Scientists and technical personnel were from six research and development agencies: the U. S. Army Engineer Research and Development Laboratories (USAERDL), Fort Belvoir, Va.; the U. S. Army Snow Ice and Permafrost Research Establishment (USASIPRE), Wilmette, Illinois; the U. S. Army Engineer Waterways Experiment Station (USAEWES), Vicksburg, Miss.; the Arctic Construction and Frost Effects Laboratory (ACFEL) of the U. S. Army Engineer Division, New England, Corps of Engineers, Boston, Mass.; the U. S. Army Electronic Proving Ground (USAEPG), Fort Huachuca, Arizona; and the U. S. Army Medical Research Laboratory (USAMRL), Ft. Knox, Ky.

CONTENTS

I. INTRODUCTION

1. This report outlines the general accomplishments of the 1958 U. S. Army Research and Development Program in Greenland. This was the fifth and most extensive year of the Greenland program since its inception in 1954. It marked the change from a totally engineering program to one involving additional technical services.

The 1958 program consisted of 22 separate projects. These were studies of the elements of engineering in regions of snow, ice, and permafrost; studies of medical problems in polar regions; and tests of equipment for polar operations.

II. SCOPE

2. The scope of the 1958 program is outlined in the Conference Notes on the 1958 U. S. Army Greenland Research and Development Program. These notes are based on the Consultants Conference held at Office, Chief of Engineers, 14-15 January 1958.

The program was accomplished as described in Section V of this report. Complete reports of project activities and results will be published by the respective agencies.

A summary of logistical support data on organic Center operations is contained in Section VI of this report.

III. ORGANIZATION AND MISSION

3. The organization of the U. S. Army Polar R&D Center for 1958 is shown in Figure 1. The mission of the Center for 1958 is:

a. To provide command and staff supervision, coordination, and planning for research and development agencies' operations in isolated arctic regions.

b. To provide administration and logistical support, communications, maintenance, and required military skills for research projects operating under Center control.

The organization of research and development agency personnel, attached to the Center in the field in 1958, is shown in Figure 2. The mission of the research and development agencies is to accomplish the project work as programmed in the Conference Notes referenced in Section II.

IV. CHRONOLOGY

4. The U. S. Army Polar R&D Center moved from Fort Belvoir, Virginia, to Northern Greenland in five increments during the period 16 March – 3 May 1958.

Research and development projects were active in field work from 10 May to 14 September 1958. The locations of the camps which were operated to support these projects are shown on the map in Figure 3.

The U. S. Army Polar R&D Center returned to Fort Belvoir, Virginia, during the period 15-22 September 1958.

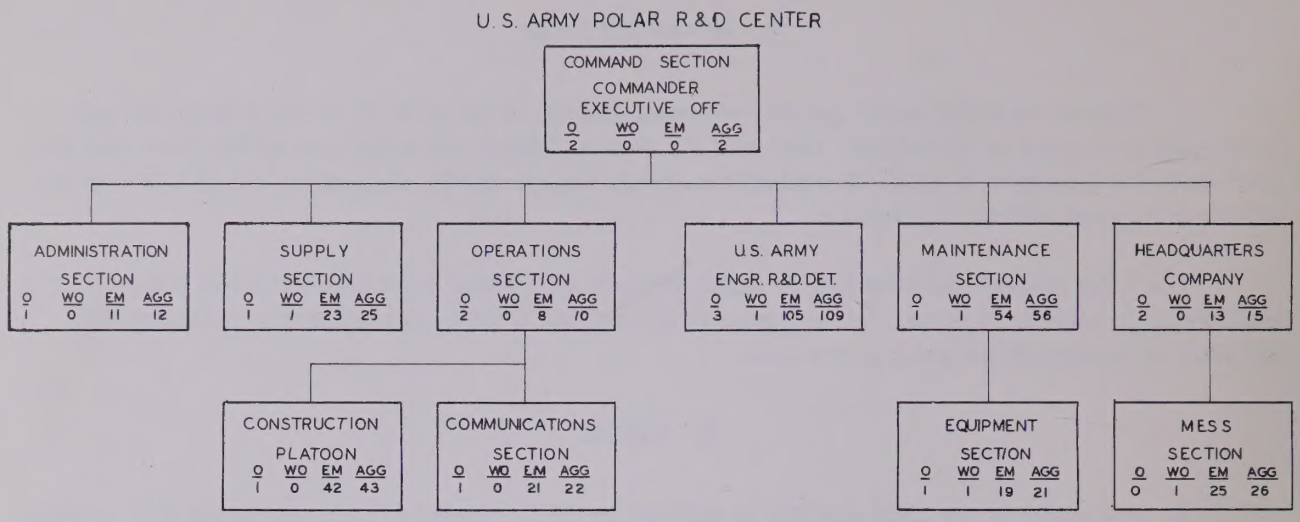

Figure 1. U. S. Army Polar R&D Center organization, 1958.

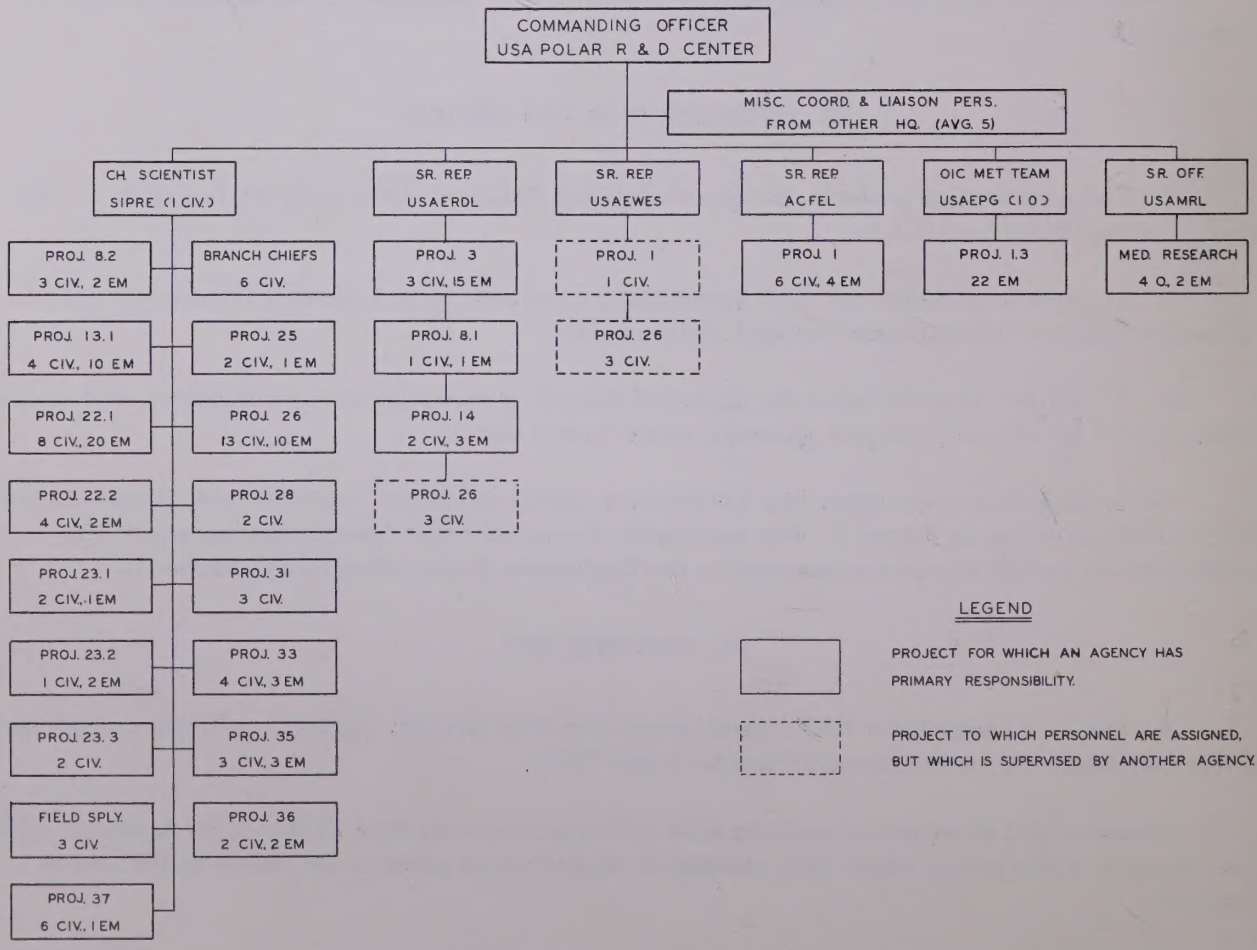

Figure 2. Project organization, 1958.

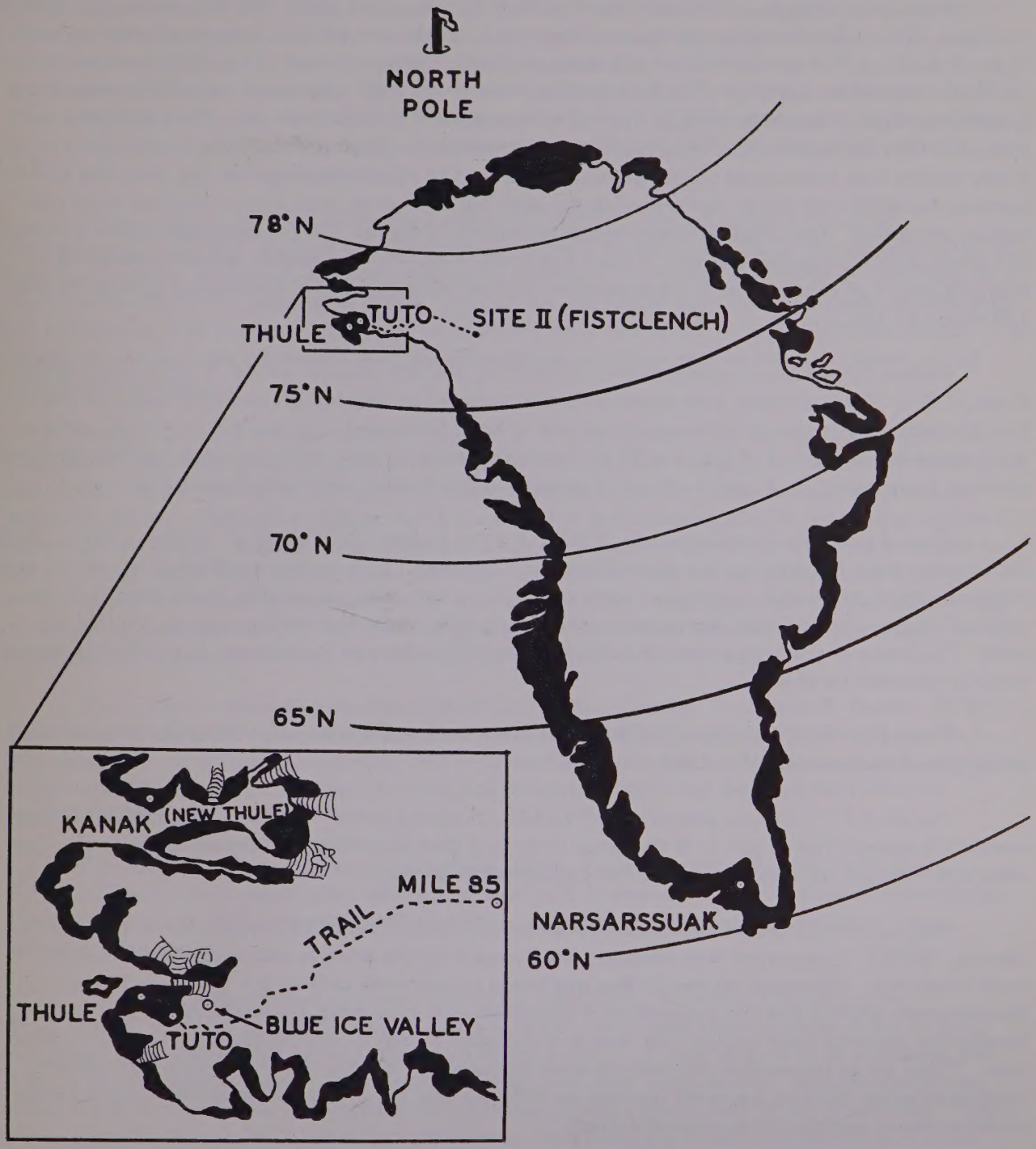

Figure 3. U. S. Army Polar R&D Center Camps, 1958.

V. PROJECT ACTIVITIES

Main projects.

5. Project results must necessarily await evaluation and interpretation of data gathered. They will then be published in final reports by the agencies concerned. The following information, however, indicates the degree to which objectives were realized:

Project 1.1 — Approach Roads (USAEWES/ACFEL, Project Leader: Mr. Robert Davis, ACFEL). The route to the new ice tunnel was surveyed and cross sections were made before and after construction. A short-span bridge with timber crib abutments sunk 6 ft into the ice was used to cross a large melt-water stream on this road. The ramp road and test berms were resurveyed and road movement was found to be slightly northwest with an over-all shortening of 9 ft since last year. Thermocouples installed in the ramp road in 1957 were reread twice a week throughout the season to obtain rate of thaw. A new culvert was constructed across the transverse road by ditching through the ice under the road, covering the ditch with plank, and replacing the earth fill. However, melt within the ditch made this culvert unsuitable. Inclinometer measurements were made along the TUTO ramp to determine movement at various depths below the surface. A pilot hydrology study of melt water on the ramp was made. Drainage area was computed as 2.3 square miles and the highest recorded discharge was slightly over 100 cfs on 12 July.

Project 1.3 — Meteorological Stations (USAEPG, Project Leader: 1st Lt. T. E. Little, Signal Corps, EPG). Three stations were established and operated as planned in the TUTO area and one at Site II. Data gathered included temperatures at 7-1/2 and 50 cm and 1, 2, and 4 m above the surface; also temperatures at 2-1/2, 7-1/2, and 25 cm below the surface; solar radiation measurements; gradient winds at three levels (1, 2, and 4 m); and standard Weather Bureau observations each hour.

Project 3 — Snow Compaction (USAERDL, Project Leader: Mr. Donald P. Kelley, ERDL). Modification kits were installed on five Pulvi-Mixers in Greenland. A camp was established at mile 85 and test sections of processed snow were constructed. The snow, after processing, had a density in the order of 0.6 g per cc and gave Rammsonde values within the range required for support of C-124 aircraft. Thickness of the layers was not sufficient, and difficulty was experienced in eliminating waves from the processed surface.

Project 6 — Trafficability (USAEWES). No field work was conducted. Observations were made on the plastic runners tested in 1957.

Project 8.1 — Crevasse Detection (USAERDL, Project Leader: Mr. Milo Olds, ERDL). Three complete Engineer Test Model 1-B Crevasse Detectors were assembled and tested on the trail. Two detectors were left for PR&DC use and one transferred to TREOG.

Project 8.2 — Crevasse Detection (Radiometer Method) (USASIPRE, Project Leader: Mr. B. L. Hansen, SIPRE). The project was seriously handicapped by the delay in obtaining clearances to enter Greenland. Personnel arrived 14 May and began project work in Blue Ice Valley on 15 May. Measurements showed that the temperature differentials over crevasses are due to the flow of air through the crevasse snow bridge. Air flow is a maximum at time of rapidly changing barometric pressure. There are no temperature differences when the snow is melting. The radiometer was partially calibrated before the melt canceled temperature differentials, but it will be necessary to make further observations to achieve the project objectives.

Project 13.1 — Snow Structures (USASIPRE, Project Leader: Mr. R. W. Waterhouse, SIPRE). The project objective was to study the construction of hemispherical undersnow rooms and to construct several hundred feet of cut-and-cover trench to determine the proper sequence of excavating and roofing operations. The air-inflated dome was found to deform excessively under "Peter" deposited snow. Five hundred feet of trench measuring 19 ft in depth, 9 ft in width at the top, and 17.5 ft in width at the bottom was produced. Level circuits were run periodically throughout the present undersnow camp to check settlements.

Project 22.1 — Ice Tunnel (USASIPRE, Project Leader: Mr. John Abel, SIPRE). A new ice

tunnel was excavated, with the portal in glacial moraine near Camp TUTO. A continuous mining machine was used to remove 11,950 cu yd of ice. The tunnel was excavated to a depth of 1100 ft and had dimensions of 16 by 15 ft at the portal. The floor ramped up to dimensions of 16 by 7-1/2 ft approximately 200 ft from the portal. Two rooms were excavated with dimensions of approximately 30 by 200 by 7-1/2 ft. One room 18 by 100 by 7-1/2 ft was excavated. Field closure rates were computed to be 7-1/2 in. per year at 105-ft depth. Temperatures ranged from −5 C near the tunnel portal to −10-1/2 C at the end of the tunnel.

Project 22.2—Ice Tunnel Instrumentation (USASIPRE, Project Leader: Dr. Hans Roethlisberger, SIPRE). Project objectives were: seismic survey of the ice in the vicinity of the ice tunnel and testing of seismic and sonic measuring equipment on the ice cap. Seismic soundings were conducted in the TUTO area and at Site II. Resistivity soundings were tried in correlation with seismic soundings. The soniscope was used on snow at Site II and on ice in both TUTO ice tunnels. The soniscope proved to be the fastest means of determining densities on core samples, where no high accuracy is needed.

Project 23.1—White-out Studies (USASIPRE, Project Leader: Mr. Marvin Diamond, SIPRE). The primary objective of the project for 1958 was to determine the feasibility of rocket or mortar shell and balloon lift of freezing nuclei (dry ice) and condensation nuclei (silver iodide) into white-out producing clouds. Twenty-two mortar shells were used in the summer trials, of which nine exploded at the desired height. Four of these produced an apparent modification of the white-out. Twenty-two dry ice aerial bombs were balloon-lifted into fogs, but success was not as verifiable as with the silver iodide. A thermocouple was lifted on several occasions by balloons into and through the fog. Temperature profiles were obtained and indicated that summer cloud temperatures may be best suited to nucleating by sodium chloride or water droplets dispersed as a fine spray.

Project 23.2—Snowdrift Studies (USASIPRE, Project Leader: Dr. Robert W. Gerdel, SIPRE). Snow accumulation from 6 August 1957 to 21 May 1958 as measured at Camp Fist Clench was 37 in. The paper strip snow fences erected in 1957 were measured for snow accumulation. A large number of the exposed strips were destroyed by wind but indications were that they had been effective most of the winter.

Project 23.3—Heat Balance Studies (USASIPRE, Project Leader: Mr. Marvin Diamond, SIPRE). Density and temperature profiles to a depth of 2 m were obtained at different locations near Camp Fist Clench. Micrometeorological data were gathered for the project by the Signal Corps Meteorological Team.

Project 26—Explosives in Snow (USASIPRE, USAERDL, USAWES, Project Leader: Mr. R. Benert, SIPRE). The 1958 project was planned to obtain data from explosion tests in hard, dry, dense snow comparable to data obtained from ice in 1957. A total of 2140 lb of explosive was fired in 134 cratering charges. Thirty of these shots were fully instrumented. Measurements were taken of air-blast pressure, undersnow shock pressure, fly rock travel, and crater dimensions. Field observations indicated that when craters were made, their diameter in feet was usually five times the cube root of the charge weight in pounds. Additional information must await analysis of the data obtained.

Project 28.2—Aerial Photographic Research Techniques—Specifications (USASIPRE, Project Leader: Dr. Jack N. Rinker, SIPRE). The season's work was directed primarily at obtaining basic information with reference to optimum photographic conditions for recording snow and ice surface detail. The 100-ft tower in Blue Ice Valley was used as a camera station to allow oblique and mean vertical photographs to be taken. The majority of the film was returned to the Wilmette laboratory for processing.

Project 31 — Trafficability (USASIPRE, Project Leader: Mr. C. J. Nuttall, Jr., Wilson, Nuttall, Raimond Engrs.) The 1958 project marked the first trials of the "Keebird" ski testing chassis, designed to test the undersnow ski concept. Tests were run at Site II which resulted in mechanical and structural difficulties that forced suspension of the program. The vehicle was dismantled and shipped to the United States for modification.

Project 33 — Pile Testing (USASIPRE, Project Leader: Mr. Nicholas C. Costes, SIPRE). Large-scale pile group tests were performed for point bearing and combined point bearing side friction. Pile group model tests were performed to determine group settlements as a function of pile spacing, pile diameter, load, and time. A pile driver was constructed and pile driving tests were performed to determine: (1) snow penetration resistance as a function of pile driving energy, (2) snow densification under various driving energies, and (3) snow side friction mobilized against driven piles.

Project 35 — Snow Runway Construction (USASIPRE, Project Leader: Mr. Albert F. Wuori, SIPRE). The objective of the 1958 season was to test cold processing methods for constructing snow runways. A total of 9 runway test lanes, consisting of 30 test sections, were constructed. The "Peter" snow miller was used to process the base course snow to a final depth of 30 to 36 in. This processed snow was then leveled and processed further. Vibratory compactors were used on many of the test sections. The vibratory frequency was varied and both the sheepsfoot and the corrugated roller were used for surface processing. Field testing included in-place CBR tests, large plate bearing tests, Rammsonde penetration tests, and density profiles.

Project 36 — Structure of the Ice-cap Névé (USASIPRE, Project Leader: Mr. Richard Ragle, SIPRE). The project was a mobile weasel party whose purpose was: (1) to observe snow conditions in the area and note structural variations to a depth of 35 ft, (2) to make meteorological observations, and (3) to make altitude determinations. The program included seven pit study stations, hardness profiles, synoptic readings every three hours, and altitude readings every mile of the traverse. Because of the crash landing of the aerial resupply C-54, only 270 miles of the 800-mile project were completed.

Project 37 — Properties of Processed Snow (USASIPRE, Project Leader: Mr. Theodore R. Butkovich, SIPRE). The project objective was to continue investigations of the properties of processed snow with emphasis directed toward the better understanding of age hardening of "Peter Snow." Over 1000 density measurements were taken. Of these, approximately 600 were rings designed to determine tensile strength as a function of time, depth, and density. Approximately 400 samples were used in unconfined compression testing to determine Young's modulus as a function of density, time, and depth.

Other projects.

6. *LGP D-8 Tractors with D-9 Engines (USAERDL, USAPR&DC).* Two LGP D-8 tractors with D-9 engines were tested on the ice cap in an attempt to improve upon the performance of the basic oversnow prime mover, the low ground pressure tractor. One had a direct drive and the other a torque converter. Speed and drawbar pull showed tremendous improvement. The only major deficiency that developed was in the torque converter, causing the engine to overheat.

Wannigans (USAERDL, USAPR&DC). Six lightweight plywood panel wannigans were tested on the trail between TUTO and Site II. The two small "recon" wannigans (14 ft) were found to be too heavy to be pulled satisfactorily by a weasel. The larger wannigans (24 ft and 36 ft) were found to have minor mechanical difficulties, but on the whole were extremely satisfactory.

"Pole Cat" (USASIPRE, USAPR&DC). An articulated oversnow vehicle constructed on two "weasel" chassis and driven by a common powerful engine through a fluid transmission and universal joints was tested for 410 miles on the ice cap. Riding characteristics and speed were found to be excellent. Further tests and minor modifications may develop the fast oversnow vehicle which is so badly needed for passengers and light cargo transport in Greenland and other polar regions.

Resurvey of Site II (AMS, USAPR&DC). A team from the Army Map Service resurveyed the location of the Polar R&D Center camp at Fist Clench (Site II), 220 miles out on the ice cap. The location had been last surveyed in 1956. The 1958 survey employed gravity meters to determine elevation, and observations on fifth magnitude stars to determine latitude and longitude. Preliminary analysis of the findings shows that the camp has moved about 600 ft to the northwest in two years, or almost a foot a day. Elevation computations in 1958 gave a preliminary elevation of 6500 ft.

VI. SUMMARY OF SUPPORTING OPERATIONS

7. The magnitude of the 1958 program required extensive Center command supervision, logistical support, and equipment maintenance. However, a happy balance was struck between the scientific effort and the logistical support available. This resulted in the outstanding success of the 1958 program.

Emphasis was given to safety, project support, supply economy, and preparation for an anticipated expanded program in 1959. The improved camp facilities at Site II immeasurably aided in the support of projects on the central ice cap. Supplies and equipment for project support were on hand in Greenland because of the early and careful programing by the Center and the agencies concerned.

The caliber of enlisted personnel in the Center was extremely high. The efforts put into recruiting and screening personnel over the winter months paid great dividends in Greenland. Project leaders were, without exception, gratified with the personnel assigned to them.

Shipments of supplies and equipment from the United States totaled 1750 short tons, of which 250 tons were air freight. Supplies moved from Camp TUTO to ice-cap camps totaled 960 tons. Five hundred thirty-nine ice-cap tons were moved by tractor swings of the Transportation Environmental Operations Group, and the remainder by PR&DC swings.

Air support for the 1958 program was provided by the TREOG air section of two L-20 aircraft (ski-equipped) and four H-19D helicopters. Forty-five passengers were transported to or from Site II (216 miles).

Equipment maintenance and operation continued to represent a large portion of the Center's effort. Major items of equipment used included: ten 16-ton trucks, six cranes, eight bulldozers, ten D-8 LGP tractors, thirty-six jeeps, forty weasels, and many miscellaneous and specialized items of equipment.

Three ice-cap camps were operated in addition to the base camp at TUTO. Blue Ice Valley camp supported one project of six personnel. The central ice-cap camp at Site II supported a maximum of 130 persons and thirteen projects. Camp TUTO itself housed approximately 450 personnel and accommodated 50 visitors. The Center maintained a minimum detachment of four persons at Thule Air Base for necessary supply and administrative functions.

The construction accomplished during the 1958 season, with both Center personnel and a construction platoon from Co."C" 588th Engineer Battalion (Constr) exceeded all previous construction

in support of the Greenland R&D program. Fifteen miles of existing roads were maintained and two miles of new road were constructed. Nonfrost-susceptible fill was placed for all new buildings. A prefabricated steel hangar 160 by 190 ft was erected and modified to withstand arctic winds. Taxiways, parking apron, and a runway 70 by 1300 ft were constructed in conjunction with the hangar. Additional construction at Camp TUTO included a headquarters, a Post Exchange, and a dispensary-laboratory, all of "Clement" panels. Insulated theater-of-operations buildings constructed were: a generator building, welding shop, spare parts warehouse, and communications building. A T-5 prefabricated building, 28 by 56 ft, was erected for use as an ordnance maintenance shop.

VII. COMMANDER'S SUMMARY

8. The success of the 1958 season can be directly attributed to the following factors:

a. Timely operational and logistical planning of support and research activities.

b. Careful selection of volunteer personnel by personal interview to man the Polar R&D Center.

Future success of the USA Polar R&D Center mission and the Army Polar R&D Program depends upon continued emphasis of the above factors and the following actions now pending.

a. Publication of a TD and TA covering the USAPR&DC.

b. Publication of an AR or similar-type policy guidance to establish command lines and procedures for all technical services and research agencies to follow in implementing the Polar R&D Program.

c. Continuing the Polar R&D Center tour in Greenland on a temporary duty basis to insure continuity of operations and the retention of high-caliber personnel.

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Commanding

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